

## REDISCOVERY OF *PLAGIOBOTHRYS HYSTRICULUS* (BORAGINACEAE) AND NOTES ON ITS HABITAT AND ASSOCIATES

ROBERT E. PRESTON, BRAD D. SCHAFER, AND MARGARET WIDDOWSON  
ICF International, 630 K Street, Suite 400, Sacramento, CA 95814  
rpreston@icfi.com

### ABSTRACT

The rediscovery of bearded popcorn flower, the last confirmed collection of which was in 1892, is documented. The species is endemic to Napa, Solano, and Yolo counties, California, where it grows in vernal pools, vernal swales, and other moist areas in grasslands. Associated species include wetland and upland grasses and forbs typically found in the vernal pool-grassland ecotone.

Key Words: Boraginaceae, endemism, *Plagiobothrys hystriculus*, rare species, vernal pools.

Bearded popcorn flower, *Plagiobothrys hystriculus* (Piper) I. M. Johnst., is a rare plant previously confirmed from only two collections from Solano Co. The last known confirmed collection was made in 1892 by Willis Jepson, whose specimens became the type of *Allocarya hystricula* Piper (Piper 1920). Jepson's specimens cited the Montezuma Hills as the general collection location but provided no other detail. The other collection was made by Katherine Brandegee in 1883. Brandegee cited her collection locality as Elmira, north of the present Jepson Prairie, where she collected many grassland and vernal pool plants. The exact location of her collection site is unknown; all of the land in the vicinity of Elmira has long since been converted to agriculture. One other partial specimen apparently collected by K. Brandegee exists (UC101495), although no date or location information is associated with the specimen.

Because *Plagiobothrys hystriculus* was known only from two historic collections and no subsequent confirmed observations of it had been made, the California Native Plant Society (2001) had listed the species as extinct. Numerous attempts by botanists over many years (including the authors of this report) to relocate the species in the Montezuma Hills area apparently had been unsuccessful (T. Messick, ICF International, personal communication). Nevertheless, *P. hystriculus* was one of the 33 plant and animal species associated with vernal pools that were included in the "Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon" (United States Fish and Wildlife Service 2005). Although not listed as threatened or endangered, it was included in the Recovery Plan to put conservation actions in place should it be rediscovered.

### REDISCOVERY

In May 2005, B. Schafer and M. Widdowson rediscovered and collected *Plagiobothrys hystri-*

*culus* in the Montezuma Hills during pre-project botanical surveys. The specimen was seen and identification confirmed by T. Messick, author of the *Plagiobothrys* treatment for the Jepson Manual (Messick 1993); the specimen was also compared with the isotype housed at the Jepson Herbarium, making this the first confirmed observation in almost 114 yr. Based on Schafer and Widdowson's description of the habitat in which the plants were found, R. Preston located two additional populations during surveys for an adjacent project. In 2006, after confirming that the species was present at the Montezuma Hills localities, Preston conducted a search for *Plagiobothrys hystriculus* at two vernal pool preserves (Wilcox Ranch, Jepson Prairie) located geographically intermediate between the Montezuma Hills and Elmira, successfully finding populations at both sites.

Although ours are the first confirmed collections of *Plagiobothrys hystriculus* since 1892, we are not the first to recollect the species. A subsequent search of the herbarium at the University of California, Davis (DAV) and the University of California/Jepson Herbaria (UC/JEPS) turned up additional specimens that had been misdetermined as *P. acanthocarpus* (Piper) I. M. Johnst., *P. greenii* (A. Gray) I. M. Johnst. or *P. glyptocarpus* (Piper) I. M. Johnst. The late Professors Beecher Crampton and John Tucker, both botanists at U. C. Davis, collected *P. hystriculus* specimens at or near Jepson Prairie in the 1960's and 1970's. Bob Holland, the noted vernal pool authority, also collected *P. hystriculus* at Jepson Prairie in 1976 and again in 1981. Jake Ruygt collected specimens in Napa Co. in 1998 while collecting for his Napa County flora project, and Ayzik Solomeshch collected *P. hystriculus* in 2002 while sampling vernal pools in Solano Co.

Why has this species been so difficult to locate? There are several likely explanations. Most of the land in the Montezuma Hills is privately owned

and not accessible for searches. The survey window for the species appears to be very narrow, as the blooming period lasts for only about three weeks, from the last week of April to the second week of May, and the plants are well into fruit and senescing by mid-May. The plants themselves are low and spreading, sometimes growing under a dense cover of *Lolium multiflorum* Lam., making detection extremely difficult. The plants are locally uncommon, occurring in small scattered stands, typically consisting of 10 to 20 plants. Annual variation in rainfall may also affect the ability of field workers to locate this species during any given year. The higher than average rainfall in 2005 and 2006 may have created optimal conditions for observing the species.

DISTRIBUTION

As currently known, the primary range of *Plagiobothrys hystriculus* consists of an approximately 150 square-mile area in central Solano Co., bordered to the south by the Montezuma Hills, to the north by Alamo and Ulatis creeks, and to the east by the Yolo Bypass. Another disjunct population occurs in Napa Co. The elevation range is from about 5 ft above sea level to about 870 ft above sea level. Although these observations have considerably expanded the known distribution of *P. hystriculus*, the species remains extremely rare and should remain a species of conservation concern. Fortunately, many of the new occurrences are located in vernal pool preserves.

HABITAT AND ASSOCIATES

Previous habitat characterizations described the habitat of *Plagiobothrys hystriculus* as “low plains” (Jepson 1925) or “grassy hillsides and plains” (Abrams 1951). Messick (1993) indicated that the habitat probably consisted of vernal pools or other wet sites, similar to other species in *Plagiobothrys* section *Allocarya*. Our observations indicate that *P. hystriculus* occurs in vernal pools and vernal swales and also in other vernal moist areas in grasslands that do not pond for significant duration but have saturated soil for long periods during the rainy season. Plants associated with *P. hystriculus* are those species commonly found at the ecotone between vernal pools and the adjacent annual grassland, including both native and introduced grasses and forbs (Table 1).

Most documented populations of *Plagiobothrys hystriculus* occur where soils have been mapped as San Ysidro sandy loam or Solano loam (Bates 1977). These soil series have increased clay content in the subsoil, which results in very slow permeability, and wetlands occur where swales or basins are present. One

population is on soil mapped as Rincon clay loam and another is on soil mapped as Capay clay (Bates 1977). The latter soil series have slow permeability but are less likely to support wetlands.

MORPHOLOGICAL COMPARISONS

The Jepson Manual key to the species of *Plagiobothrys* (Messick 1993) generally works well for section *Allocarya*. However, persons unfamiliar with the nutlet morphology or with the corresponding terminology could experience difficulty using the key. *Plagiobothrys hystriculus* is one of only four species (*P. acanthocarpus*, *P. austinae* [Greene] I. M. Johnst., *P. greenei*, *P. hystriculus*) that have prickles, large (ca. 1 mm) spine-like projections, on the abaxial nutlet surface (Fig. 1b–d). The prickles on these species are also beset with short, hair-like bristles that spread at right angles or curve towards the base of the prickles. Several other *Plagiobothrys* species have nutlets with bristles (*P. leptocladus* [Greene] I. M. Johnst., *P. hispidulus* [Greene] I. M. Johnst., *P. humistratus* I. M. Johnst., *P. scriptus* [Greene] I. M. Johnst.); however, all of these species lack prickles. *Plagiobothrys glyptocarpus* (Fig. 1a) and *P. trachycarpus* I. M. Johnst. (Fig. 1e) sometimes have very short prickles (ca. 0.1–0.2 mm) lacking bristles.

KEY TO THE *PLAGIOBOTHRYS* SPECIES WITH BOTH PRICKLES AND BRISTLES

- 1. Prickles on nutlet margins and abaxial ridge only; nutlet surface smooth, ridges or papillae obscure . . . . . *P. austinae*
- 1' Prickles evenly distributed abaxially on nutlet; nutlet surface with ridges and/or papillae
  - 2. Nutlet surface prominently ridged abaxially and adaxially, the spaces between ridges with coarse papillae . . . . . *P. acanthocarpus*
  - 2' Nutlet surface lacking ridges or with obscure adaxial ridges, finely papillate
    - 3. Nutlet surface papillae glabrous, ridges absent; bristles arched towards base of prickles; only lowermost flowers of inflorescence bracted. . . . . *P. greenei*
    - 3' Nutlet surface papillate, papillae densely bristled, adaxial surface with obscure ridges; bristles short, straight; inflorescence bracted throughout . . . . *P. hystriculus*

SPECIMENS EXAMINED

The following collections summarize the known localities for *Plagiobothrys hystriculus* (additional collections/duplicates not listed have been distributed). USA. CALIFORNIA. **Napa Co.:** 4.7 mi N of first bridge on Berryessa-Knoxville Rd, *J. Rygjt* 3981 (JEPS). **Solano Co.:** Montezuma Hills, *W. L. Jepson* 21176 (JEPS).

TABLE 1. SPECIES OCCURRING WITH *PLAGIOBOTHRYS HYSTRICULUS*, RECORDED IN 24 1-M DIAMETER PLOTS IN SOLANO CO., CALIFORNIA.

Species	Frequency
<i>Lolium multiflorum</i> Lam.	95.83%
<i>Lythrum hyssopifolium</i> L.	83.33%
<i>Juncus bufonius</i> L.	62.50%
<i>Hordeum marinum</i> Hudson subsp. <i>gussoneanum</i> (Parl.) Thell.	50.00%
<i>Achyraea mollis</i> Schauer	41.67%
<i>Eryngium aristulatum</i> Jepson	37.50%
<i>Crassula aquatica</i> (L.) Schönl.	29.17%
<i>Plagiobothrys stipitatus</i> (Greene) I. M. Johnst.	25.00%
<i>Geranium dissectum</i> L.	20.83%
<i>Bromus hordeaceus</i> L.	16.67%
<i>Cicendia quadrangularis</i> (Lam.) Griseb.	16.67%
<i>Plagiobothrys greenei</i> (A. Gray) I. M. Johnst.	16.67%
<i>Psilocarphus tenellus</i> Nutt.	16.67%
<i>Rumex crispus</i> L.	16.67%
<i>Briza minor</i> L.	12.50%
<i>Lasthenia fremontii</i> (A. Gray) Greene	12.50%
<i>Plagiobothrys bracteatus</i> (T. J. Howell) I. M. Johnst.	12.50%
<i>Plantago coronopus</i> L.	12.50%
<i>Pogogyne zizyphoroides</i> Benth.	12.50%
<i>Ranunculus muricatus</i> L.	12.50%
<i>Trifolium depauperatum</i> Desv.	12.50%
<i>Triphysaria eriantha</i> (Benth.) T. I. Chuang & Heckard	12.50%
<i>Cotula coronopifolia</i> L.	8.33%
<i>Deschampsia danthonioides</i> (Trin.) Munro	8.33%
<i>Downingia concolor</i> Greene	8.33%
<i>Erodium botrys</i> (Cav.) Bertol.	8.33%
<i>Linnanthus douglasii</i> R. Br.	8.33%
<i>Phalaris lemmonii</i> Vasey	8.33%
<i>Trifolium dubium</i> Sibth.	8.33%
<i>Veronica peregrina</i> L.	8.33%
<i>Aira caryophylla</i> L.	4.17%
<i>Avena barbata</i> Link	4.17%
<i>Brodiaea elegans</i> Hoover	4.17%
<i>Convolvulus arvensis</i> L.	4.17%
<i>Holocarpha virgata</i> (A. Gray) Keck	4.17%
<i>Lasthenia californica</i> Lindl.	4.17%
<i>Lasthenia glaberrima</i> A DC.	4.17%
<i>Lotus corniculatus</i> L.	4.17%
<i>Plagiobothrys leptocladus</i> (Greene) I. M. Johnst.	4.17%
<i>Pleuropogon californicus</i> (Nees) Benth. ex Vasey	4.17%
<i>Poa annua</i> L.	4.17%
<i>Psilocarphus oregonus</i> Nutt.	4.17%
<i>Trifolium gracilentum</i> Torr. & A. Gray	4.17%
<i>Vulpia myuros</i> (L.) C. C. Gmel.	4.17%

isotype); Elmira, K. Brandegee, May 1883 (UC); 2 mi NE of Dozier Station, at jct Brown and Robbins roads, B. Crampton 6334 (AHUC); 2 mi SW of Dozier Station, B. Crampton 8700 (UC, AHUC); on N side of small road running W from intersection of Cook Lane and Sacramento Northern Railroad, ca. 1/2 mi W of this intersection, J. M. Tucker 4348 (DAV); N of Alkali Lake, Dozier, R. Holland 167 (UC); Jepson Prairie TNC Preserve, Section 23, R. Holland 1082 (UC); Gridley Ranch, 1 mi N from intersection of Hastings Rd and Salem Rd, A. Solomeshch, 27 Apr 2002 (DAV); Montezuma Hills, approximately 1 mi S of the junction of CA Hwy 12 and CA Hwy 113, Brad D. Schafer 135 & Margaret Widdowson (JEPS), Brad D. Schafer 137 & Margaret Widdowson (DAV); Montezuma Hills, approximately 1.5 mi S of Hwy 12 and E of Olsen Rd, R. E. Preston 2347 (JEPS); Kirby Hill, at toe of north slope, R. E. Preston 2348 (DAV); 4.6 mi E of Travis Air Force Base, at Wilcox Ranch Preserve, R. E. Preston 2383 (DAV); 3 mi E of Travis Air Force Base, at Wilcox Ranch Preserve, R. E. Preston 2389 (DAV); Jepson Prairie Preserve, 1.4 mi SSW of the intersection of Cook Lane and Hwy 113, R. E. Preston 2393 (DAV). Yolo Co.: DFG Tule Ranch, C. W. Witham 1562 (DAV).



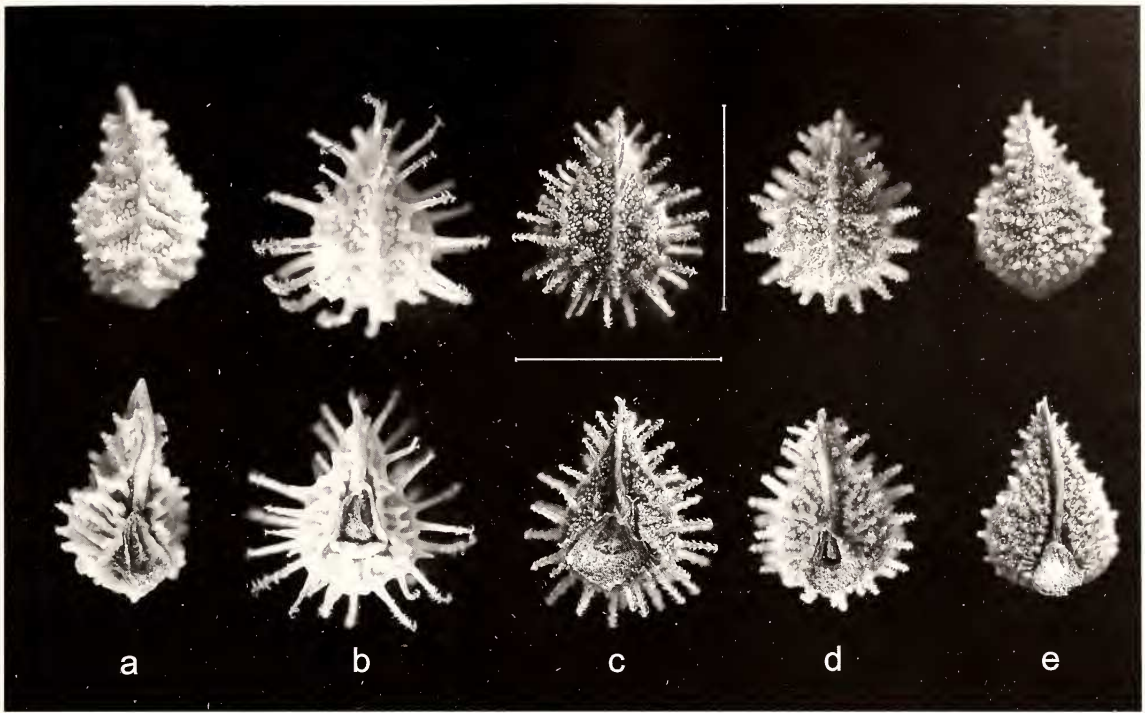


FIG. 1. Comparison of the nutlets of five *Plagiobothrys* species. a. *P. glyptocarpus*. b. *P. acanthocarpus*. c. *P. greenei*. d. *P. hystriculus*. e. *P. trachycarpus*. Scale bars = 3.0 mm.

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LITERATURE CITED

ABRAMS, L. 1951. Illustrated flora of the Pacific States, Volume III: Geraniaceae to Scrophulariaceae. Stanford University Press, Stanford, CA.  
BATES, L. A. 1977. Soil survey of Solano County, California. U.S. Department of Agriculture, Soil Conservation Service, in cooperation with University of California Agricultural Experiment Station, Washington, DC.

CALIFORNIA NATIVE PLANT SOCIETY. 2001. Inventory of rare and endangered plants of California (sixth edition). Rare Plant Scientific Advisory Committee, David P. Tibor, Convening Editor. California Native Plant Society, Sacramento, CA.  
JEPSON, W. L. 1925. A manual of the flowering plants of California. Associated Students Store, Berkeley, CA.  
MESSICK, T. C. 1993. *Plagiobothrys*. Pp. 386–390 in J. C. Hickman (ed.), The Jepson manual: higher plants of California. University of California Press, Berkeley, CA.  
PIPER, C. V. 1920. A study of *Allocarya*. Contributions from the U.S. National Herbarium 22:79–113.  
UNITED STATES FISH AND WILDLIFE SERVICE. 2005. Recovery plan for vernal pool ecosystems of California and southern Oregon. U.S. Fish and Wildlife Service, Portland, OR. Website [http://www.fws.gov/sacramento/es/recovery\\_plans/vp\\_recovery\\_plan\\_links.htm](http://www.fws.gov/sacramento/es/recovery_plans/vp_recovery_plan_links.htm) [accessed 28 December 2010].